BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D.C. 20024

SUBJECT: Value of a Two Hour Exposure for the Solar Wind Composition Experiment
Case 340

DATE: September 30, 1968

FROM: W. L. Piotrowski

ABSTRACT

The value of a two hour lunar surface exposure of the Solar Wind Composition (SWC) foil to direct solar wind impingement is reviewed.

Assuming a solar wind flux of 5×10^{8} particles/cm^{2}-sec, a trapping probability of unity, and a solar-wind abundance equivalent to the solar abundance, a two hour exposure of the SWC foil on the lunar surface should permit the determination of the solar wind elemental abundance of He, Ne, and A and the isotopic abundances of $He^{3,4}$, $Ne^{20,21,22}$ and $A^{36,38}$. Longer exposures would be required for determination of other species assumed to constitute the solar wind.

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MEMORANDUM FOR FILE

I. INTRODUCTION

Current mission planning for Apollo is considering a one man open-ended lunar surface EVA of up to 3 hours. The EVA timelines of this mission indicate insufficient time for deployment of ALSEP and for complete implementation of the Field Geology Investigation. Studies of possible contingency science experiments for Apollo indicate that the Solar Wind Composition Experiment may yield useful information if sufficient exposure time and/or exposure surface is available. In this memorandum we examine the data which could be obtained under ideal conditions with a two hour exposure of the foil on the lunar surface but do not consider the significance of the questions this information may answer.

II. CONTINGENCY SOLAR WIND COMPOSITION EXPERIMENT

The Solar Wind Composition Experiment (SWC) consists of a 4.5 ft^2 aluminum foil approximately 3 mils thick which will be exposed on the lunar surface to the assumed direct impingement of the solar wind. Solar wind particles with energies in the range from about 3-100 Kev will be trapped in the foil and particles of higher energy will pass through it. The exposed foil will be returned to earth, vaporized in an ultrahigh vacuum system, most of the reactive gases removed by gettering action, and the remaining gases (mostly noble gases) subjected to mass spectroscopic analysis. The principal investigators hope to determine the elemental and isotopic composition and relative abundances of the noble gases and other selected elements in the solar wind.

In the contingency situation, however, the ALSEP solar wind experiments will not be carried and the SWC experiment will not have the advantage of direct comparison with the other lunar surface solar wind experiments. Nevertheless, the SWC experiment will yield significant information if sufficient exposure time is available. In order to assure that the integrated flux is greater than the detection threshold of the laboratory analysis for the most abundant isotopic species of the noble gases in the solar wind, the principal investigator has requested an exposure of 90 ft^2-hrs. This experiment is susceptible to contamination from lunar dust particles and parts of the foil on which dust particles are found must be discarded. Therefore, for maximum science return from the remaining foil, a greater exposure time is desirable.

Assuming a solar wind flux of 5×10^8 particles/cm^2-sec, a trapping probability of unity, and a solar-wind abundance equivalent to the solar abundance, the principal investigator indicates that an exposure on the lunar surface of 9 ft^2-hrs (2 hrs for the 4.5 ft^2 foil) will permit the determination of the elemental abundance of He, Ne, and A and the isotopic abunces of $He^{3,4}$, $Ne^{20,21,22}$ and $A^{36,38}$. An estimate of the elemental abundance of Kr and an estimate of the isotopic abundances of Kr^{82-86} should also be possible with this exposure. An exposure of 20 hrs for this foil would enable the principal investigator to also determine the elemental abundance of Kr and the isotopic abundances of Kr^{82-86} and enable an estimate of the elemental abundance of Xe and the isotopic abundances of Kr^{80}, $Xe^{129,131-136}$ and A^{40}. Considerably longer exposures would be required to unambiguously determine these abundances and estimate the isotopic abundances of Kr^{78} and $Xe^{124-128,130}$. The principal investigator does not give a threshold sensitivity for his laboratory analysis for the other elemental and isotopic species assumed to constitute the solar wind.

III. ONE VS. TWO SWC FOILS

The threshold sensitivity of the laboratory analysis is determined by the contamination level of the foil by terrestrial noble gases. Consequently, two foils exposed on the lunar surface would not increase the sensitivity of the experiment nor permit the determination of the less abundant species but would obviously improve the counting statistics. However, the inclusion of an additional foil only to improve the counting statistics does not appear to be desirable in the contingency situation.

In the proposal the principal investigator infers that with an additional foil it may be possible to determine the energy of the incident solar wind ions by controlled removal of surface layers or by thermal release patterns. However, the feasibility of these techniques has not been demonstrated nor does the proposal state the minimum exposure required for the analysis. In the event that the techniques are proved feasible, and if an exposure of 9 ft^2-hrs would yield usable information, then the inclusion of a second SWC foil might be warranted.

IV. SIGNIFICANCE OF DATA

The significance of the data obtained from this experiment is astrophysical and pertains to the moon only so far as the solar wind interacts with the moon. The most significant astrophysical results are expected in the fields of nucleosynthesis, the origin and development of the solar system, nuclear reactions at the solar surface and the history of planetary atmospheres.

A knowledge of the composition of the solar wind may also assist in the analysis of searches for trace elements of primordial noble gases in the returned lunar samples. It is anticipated that trapped solar wind particles will be found in the lunar surface materials in addition to the primordial gas components. Although saturation effects and diffusion losses due to solar heating may alter the abundances of the noble gases from the solar wind found in these materials, the SWC experiment will aid in distinguishing the solar noble gas component from the primordial gas component.

Although a two hour exposure of the SWC foil on the lunar surface would yield less information on the elemental and isotopic abundances of the solar wind than a somewhat longer exposure, the experiment nevertheless would contribute new and unique data on the composition of the solar wind.

V. DEPLOYMENT

The SWC foil is a rectangular sheet approximately 15x43 inches and about 3 mils thick backed by an open net fabric of Teflon or Nylon for resistance to tear during deployment. A staff and yard arrangement would be used to deploy the foil and to maintain the foil perpendicular to the solar wind. For outbound stowage the foil is rolled and fits into a hole in the ALSEP tool carrier 15 inches deep and 1 1/4 inch in diameter. There are no stowage constraints for the foil on the outbound flight. Consequently, if the tool carrier is deleted from the flight, the SWC foil can be stowed anywhere sufficient space is available.

After exposure on the lunar surface the foil is rolled and returned to earth along with exposed film in film cassettes. Since the foil could be contaminated by lunar dust which has already been saturated with the noble gases, care must be taken to avoid this source of contamination.

The launch weight of the SWC Experiments is 1.0 lbs and the return weight is 0.20 lbs. MSC estimates 15 minutes of EVA time for deployment and recovery.

VI. CONCLUSION

A two hour exposure on the lunar surface of the SWC foil should enable the principal investigator to determine the solar wind elemental abundances of He, Ne, and A and the isotopic abundances of $He^{3,4}$, $Ne^{20,21,22}$ and $A^{36,38}$. An estimate of the elemental abundance of Kr and an estimate of the isotopic abundances of Kr^{82-86} may also be possible with this exposure.

Because of its technical simplicity, minimum astronaut involvement, small return weight, and uniqueness of the data, the SWC Experiment is a prime candidate for inclusion on an Apollo contingency science package.

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